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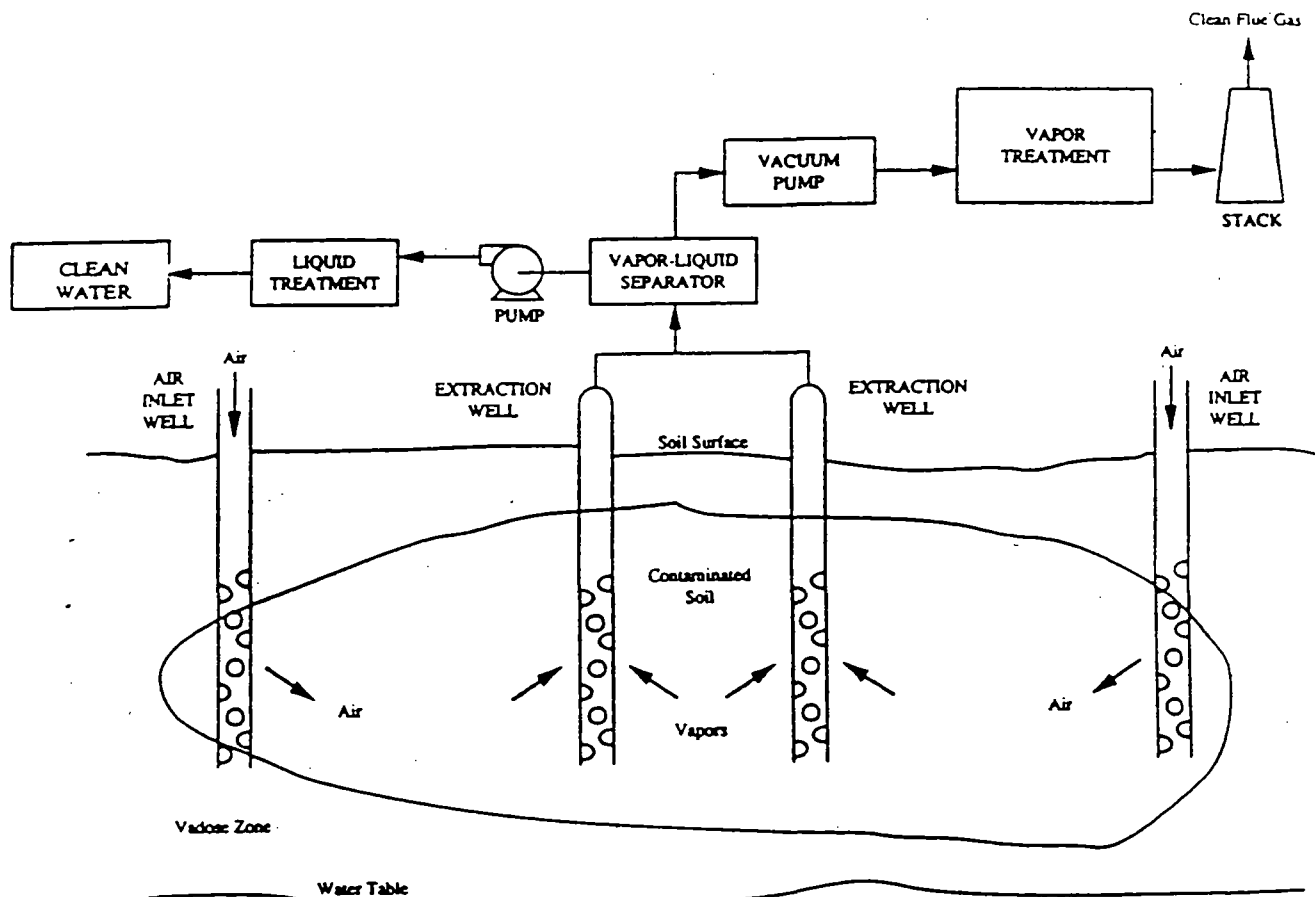
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## ESTIMATION OF AIR IMPACTS FOR SOIL VAPOR EXTRACTION (SVE) SYSTEMS

### Purpose

The analysis of air impacts from various remedial options are frequently required for planning purposes prior to actual remediation and are dependent on the ability to estimate emissions rather than on field measurement approaches. The purpose of this project is to provide procedures for estimating the ambient air concentrations associated with Soil Vapor Extraction (SVE) systems.



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## Technical Objective

The specific objective of this project is to provide procedures for estimating the ambient air concentrations associated with SVE.

## Approach

This report provides procedures for roughly estimating the ambient air concentrations associated with SVE. The procedures for SVE systems are analogous to procedures for air strippers that have previously been published. SVE is also known as soil venting, vacuum extraction, aeration, or in situ volatilization. It is a widely used technique for removing volatile organic compound (VOC) vapors from contaminated soil. Procedures are provided to evaluate the effect of the concentration of the contaminants in the soil-gas and the extraction rate on the emission rates and on the ambient air concentrations at selected distances from the SVE system.

Health-based ambient air action levels are also provided for comparison to the estimated ambient concentrations. Many of the health levels have not been verified by EPA or are based on extrapolations of oral exposures or occupational exposures. Their indiscriminate use could either under or over estimate the potential health effects.

## Results

There are several alternative approaches for estimating the emissions from a SVE system. The best method is to directly measure the emissions from the system while it is in full-scale or pilot-scale operation. The next best method is to estimate the emissions using predictive equations with site-specific inputs. If site-specific inputs are not available, a very conservative estimate can be made by using default values for the input parameters. Equations are provided for estimating both long-term and short-term emission rates.

### Long-Term Average Emission Rate

$$ER = (S_v)(C_s)(\beta)(1)/t$$

where: ER = Average emission rate (g/s)

$S_v$  = Volume of contaminated soil to be treated ( $m^3$ )

- $C_e$  = Average contaminant concentration ( $\mu\text{g/g}$ )  
 $\beta$  = Bulk density of soil ( $\text{g/cm}^3$ )  
 $1$  = Constant ( $\text{g}/10^6 \mu\text{g} * 10^6 \text{cm}^3/\text{m}^3$ )  
 $t$  = Duration of remediation (s).

This equation assumes 100 percent recovery of the contamination at the site. The volume of contaminated soil and the total mass of each contaminant of concern are typically determined during the remedial investigation (RI), while the percent that can be recovered using SVE is typically determined during the feasibility study (FS). The duration of the cleanup will usually be limited by the rate at which contaminants can be cost-effectively extracted from the ground. For this equation, a typical default value for bulk density of uncompacted soil is  $1.5 \text{ g/cm}^3$ .

### Short-Term Emission Rate

The primary parameters affecting the emission rate of a given compound from a SVE system are: the concentration of the contaminant in the soil, the volatility of the contaminant (i.e., its vapor pressure), the soil permeability to air flow, and the vacuum well pressure.

In practice, field tests are typically performed to assess the potential effectiveness of SVE for a given site. The field tests may be pilot-scale demonstrations of SVE or tests of soil-air permeability.

The results of the field tests can be used to estimate the emission rate (ER) in grams per second as follows:

$$ER = (C_e) \left[ \frac{Q}{60} \right] (10^{-6})$$

- where:
- $ER$  = Emission rate ( $\text{g/s}$ )  
 $C_e$  = Concentration in extracted vapors ( $\mu\text{g/m}^3$ )  
 $Q$  = Vapor extraction rate ( $\text{m}^3/\text{min}$ )  
 $1/60$  = Conversion factor ( $\text{min/s}$ )  
 $10^6$  = Conversion factor ( $\text{g}/\mu\text{g}$ ).

## **Estimation of Ambient Air Concentrations**

Estimates of short-term ambient concentrations should be obtained by using site-specific release parameters in EPA's SCREEN model. Estimates of long-term concentrations should be obtained by using EPA's Industrial Source Complex (ISCLT) model. Here, for simplicity, the long-term estimates are derived by multiplying the short-term estimate obtained from the SCREEN model, by a conversion factor to obtain the annual average estimates. This approach results in a higher estimate of the annual average concentration than if the ISCLT model, with site-specific data, is used.

## **Conclusions**

The procedures presented here are not intended to negate the need for rigorous analyses that consider site-specific meteorological conditions and the health effects of the specific compounds involved. Although the procedures are based on what is typical and reasonable for cleaning up Superfund sites, the underlying assumptions need to be kept in mind. Emission models assume steady-state conditions, dispersion models assume Gaussian distribution of the plume contaminant concentration, and many of the health levels are not endorsed by EPA. EPA's Regional Toxicologist should be contacted for general toxicological information and technical guidance on evaluation of chemicals without established toxicity values.

### **Project Officer**

Mr. James Durham  
U.S. Environmental Protection Agency  
MD-13  
Research Triangle Park, North Carolina 27711  
(919) 541-5672

## **WHERE CAN I OBTAIN COPIES OF THIS VOLUME?**

Office of Air Quality Planning and Standards  
Joseph Padgett  
(919) 541-5589 (FTS 629-5589)

or

National Technical Information Service  
5285 Port Royal Road  
Springfield, Virginia 22161  
(703) 487-4650  
(Doc. No. PB92-143676/AS)